REMARKS

Claims 2-11 and 13-16 again were rejected under 35 USC §103(a) as being unpatentable over the patent to Chang et al (U.S. 5,808,793) in view of the patent publication to Trotter, Jr. (U.S. 2002/0154403). Reconsideration of this rejection is respectfully requested in view of the following detailed remarks and comments.

Initially, applicants are of the opinion that it may be of assistance to first define an "optical isolator." The definition of an "optical isolator" is given on pages (2-1)-(2-2) of the document (Telcordia Technologies) attached hereto.

More specifically, in accordance with the description made under "Figure 2-1 Symbols for (a) an Optical Isolator" of the document, an "optical isolator" is so defined as to have such a function that, when Figure 2-1(a) is viewed in which the "optical isolator" is shown, a lightwave directed along its optical path from left to right is passed therethrough, but a lightwave directed along its optical path from right to left is blocked. That is, the "optical isolator" is defined as a device which is put in place on optical paths provided with two ports, and functions to pass a lightwave from one port to the other port, but to block a lightwave tending to pass in the opposite direction.

Because of the function of the "optical isolator" to intercept light passing in the opposite direction, the technical problem stated under "2.1 General Product Description" on page (2-1) of the above document (the technical problem noted here is identical with the counterpart described on

page 1, lines 20-25, of the specification on file) can be solved. That is, the above function of the "optical isolator" provides solution to the technical problem, i.e., "when reflection return light returns to the semiconductive laser device, laser oscillation of the semiconductive laser device becomes unstable."

Thus, as discussed in the previously filed Request for Reconsideration, any device which passes both forward-directed light and reflection return light does not fall under the category of an "optical isolator" defined by the above document (Telcordia Technologies), i.e., the Telcordia Standard.

In the subject rejection under 35USC 103, it again was asserted that the publication to Trotter discloses an "optical isolator" and that the claimed invention would have been obvious to one of ordinary skill in the art under combined teachings of the patent to Chang, which discloses a broadband semidouble-type optical isolator.

More specifically, it was asserted that Chang patent discloses in Fig. 4 a polarization-dependent optical isolator unit made up of a polarizer (49a), a Faraday rotator (45a), a polarizer (49b), a Faraday rotator (45b) and a polarizer (49c), and that the broadband semidouble-type optical isolator of the claimed invention can be made up by replacing these polarizers (49a, 49c) with the polarizers of the Trotter publication each comprising photonic crystals.

However, as stated previously, the optical isolator of the Trotter publication is a structure

having not any function required in the "optical isolator" defined by the Telcordia Standard. Hence, there can not be any technical inducement to use the optical isolator of the Trotter publication that does not function as any optical isolator, in combination with the broadband semidouble-type of the Chang patent.

In support of the above, consideration is to be given to the following:

(1) Conventional polarization-dependent optical isolator making use of glass polarizer

Conventional polarization-dependent optical isolators making use of glass polarizers have the structure of glass polarizer/Faraday rotator/glass polarizer as shown in Fig. 1A attached thereto.

Then, as shown in Fig. 1B, forward-directed light passes through the incident-side glass polarizer (on the left side as viewed in Fig. 1A) and thereafter its plane of polarization is rotated by 45° at the Faraday rotator, and hence the light passes through the emergent-side glass polarizer (on the right side as viewed in Fig. 1A) without any attenuation of light (see page 2, lines 9-14, of the subject specification).

On the other hand, as for reflection return light, as shown in Fig. 1C, even where it has passed through the emergent-side glass polarizer (on the right side as viewed in Fig. 1A), its plane of polarization is rotated by 45° at the Faraday rotator, and hence the light crosses the plane of polarization of the incident-side glass polarizer (on the left side as viewed in Fig. 1A) to come

intercepted (see page 2, lines 15-21, of the subject specification).

Since the glass polarizer is an absorption type polarizer, the above reflection return light is absorbed in the incident-side glass polarizer (on the left side as viewed in Fig. 1A) to come intercepted without being reflected at this glass polarizer.

Thus, such a conventional polarization-dependent optical isolator making use of glass polarizers falls under the category of the "optical isolator" defined by the above Telcordia Standard.

(2) <u>The optical isolator of the Trotter publication making use of polarizer comprising photonic crystals</u>

The optical isolator of the <u>Trotter</u> publication makes use of a polarizer comprising photonic crystals having the structure of photonic crystal polarizer/Faraday rotator/photonic crystal polarizer as shown in Fig. 2A attached thereto.

Then, as shown in Fig. 2B, forward-directed light passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 2A) and thereafter its plane of polarization is rotated by 45° at the Faraday rotator, and hence the light passes through the emergent-side photonic crystal polarizer (on the right side as viewed in Fig..2A) without any attenuation of light.

On the other hand, as for reflection return light, as shown in Fig. 2C, even where it has passed through the emergent-side photonic crystal polarizer (on the right side as viewed in Fig. 2A), its

plane of polarization is further rotated by 45° at the Faraday rotator, and hence the light crosses the plane of polarization of the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 2A) to be intercepted.

However, the photonic crystal polarizer differs from a glass polarizer and is a reflection type polarizer (see column 2, lines 1-2 and Fig. 2 of the Trotter publication), and hence the light intercepted at the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 2A) is reflected at this photonic crystal polarizer and again enters the Faraday rotator.

Then, its plane of polarization is further rotated by 45° by the Faraday rotator, and hence the light crosses the plane of polarization of the incident-side photonic crystal polarizer (on the right side as viewed in Fig. 2A) to be intercepted. Also, the light thus intercepted is reflected at this photonic crystal polarizer and again enters the Faraday rotator, where its plane of polarization is rotated by 45°, and finally unwantedly passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 2A).

Thus, in the optical isolator of the Trotter publication makes use of a polarizer comprising photonic crystals, the reflection return light is repeatedly reflected twice in the interior of the optical isolator and finally unwantedly passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 2A), and hence such an optical isolator does not function as an "optical isolator" defined by the above Telcordia Standard.

Since the optical isolator of the Trotter publication does not function as the "optical isolator" defined by the above Telcordia Standard, there is no technical inducement to use the optical isolator of the Trotter publication that does not function as any optical isolator, in combination with the broadband semidouble-type of the Chang patent.

(3) If by any chance one were to accept the position of the Examiner and follow it to combine the broadband semidouble-type optical isolator of the Chang patent with the optical isolator of the Trotter publication, it is natural that the polarizers are so used that all the three polarizers (49a, 49b, 49c) would be replaced with the polarizer comprising photonic crystals, and it is of no technical necessity that the position was taken that only two polarizers (49a, 49c) among the polarizers provided in threes (49a, 49b, 49c) are selectively replaced with the polarizer comprising photonic crystals.

Moreover, as will be stated later, an optical isolator that is made up of polarizers which are so used that all the three polarizers (49a, 49b, 49c) are replaced with the polarizer comprising photonic crystals does not function as the "optical isolator" defined by the above Telcordia Standard. In contrast, an optical isolator made up such that only two polarizers (49a, 49c) among the polarizers provided in threes (49a, 49b, 49c) are replaced with the polarizer comprising photonic crystals can function as the "optical isolator" defined by the Telcordia Standard. In view of such a significant difference, it is submitted that these optical isolators do not equate with each other.

An important reason for such a submission is that broadband semidouble-type optical isolator that may be made up of polarizers which are so used that all the three polarizers (49a, 49b, 49c) of the Chang patent are replaced with the polarizer comprising photonic crystals comes to what has the structure shown in Fig. 3A attached hereto.

More specifically, as shown in Fig. 3A, this broadband semidouble-type optical isolator has the structure of photonic crystal polarizer/Faraday rotator/photonic crystal polarizer/Faraday rotator/photonic crystal polarizer.

However, in the broadband semidouble-type optical isolator shown in Fig. 3A, too, the reflection return light is, as shown in Fig. 3B, repeatedly reflected four times in the interior of the optical isolator and finally unwantedly passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 3A), and hence such an optical isolator by no means functions as the "optical isolator" defined by the Telcordia Standard, as is the case with the optical isolator of the Trotter publication.

More specifically, as shown in Fig. 3B, even where the reflection return light has passed through the emergent-side photonic crystal polarizer (on the right side as viewed in Fig. 3A), its plane of polarization is rotated by 45° at the Faraday rotator near to the emergent side (the second from the right as viewed in Fig. 3A), and hence the light crosses the plane of polarization of the middle-positioned photonic crystal polarizer (the middle as viewed in Fig. 3A) adjacent to this

Faraday rotator, to come intercepted.

Since, however, this photonic crystal polarizer is a reflection type polarizer as stated previously, the light intercepted at the middle-positioned photonic crystal polarizer (the middle as viewed in Fig. 3A) is reflected at this photonic crystal polarizer, and again enters the Faraday rotator near to the emergent side (the second from the right as viewed in Fig. 3A).

Then, its plane of polarization is further rotated by 45° by this Faraday rotator, and hence the light crosses the plane of polarization of the emergent-side photonic crystal polarizer (on the right side as viewed in Fig. 3A) to come intercepted. Also, the light thus intercepted is reflected at this photonic crystal polarizer, and again enters the Faraday rotator near to the emergent side (the second from the right as viewed in Fig. 3A), where its plane of polarization is further rotated by 45°, and therefore passes through the middle-positioned photonic crystal polarizer (the middle as viewed in Fig. 3A) and also enters the Faraday rotator near to the incident side (the second from the left as viewed in Fig. 3A).

As to the reflection return light having entered the Faraday rotator near to the incident side (the second from the left as viewed in Fig. 3A), its plane of polarization is rotated by 45° at this Faraday rotator, and hence the light crosses the plane of polarization of the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 3A) to be intercepted. Also, the light thus intercepted is reflected at this photonic crystal polarizer and again enters the Faraday rotator near to

the incident side (the second from the left as viewed in Fig. 3A).

Then, its plane of polarization is further rotated by 45° by this Faraday rotator, and hence the light crosses the plane of polarization of the middle-positioned photonic crystal polarizer (the middle as viewed in Fig. 3A) to be intercepted. Also, the light thus intercepted is reflected at this photonic crystal polarizer and again enters the Faraday rotator near to the incident side (the second from the right as viewed in Fig. 3A), where its plane of polarization is further rotated by 45°, and passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 3A).

Thus, in the broadband semidouble-type optical isolator in which all the three polarizers (49a, 49b, 49c) in the Chang patent are replaced with the polarizer comprising photonic crystals, the reflection return light is repeatedly reflected four times in the interior of the optical isolator and finally unwantedly passes through the incident-side photonic crystal polarizer (on the left side as viewed in Fig. 3A), and hence such an optical isolator by no means functions as the "optical isolator" defined by the Telcordia Standard.

Thus, even if the broadband semidouble-type optical isolator of the Chang patent is combined with the optical isolator of the Trotter publication as asserted, it is unable to make up the broadband semidouble-type optical isolator of the claimed invention, which functions as the "optical isolator" defined by the Telcordia Standard.

(4) Broadband semidouble-type optical isolator of the claimed invention

In the broadband semidouble-type optical isolator recited in claim 2 of the present application, the middle-positioned polarizer is made up of the glass polarizer and also the outer-side polarizer is made up of the polarizer comprising photonic crystals.

More specifically, the broadband semidouble-type optical isolator of the claimed invention has the structure of photonic crystal polarizer/Faraday rotator/glass polarizer/Faraday rotator/photonic crystal polarizer.

Then, the broadband semidouble-type optical isolator of the claimed invention enables itself to function as the optical isolator because any reflection of the reflection return light does not take place in the interior of the optical isolator.

That is, in the broadband semidouble-type optical isolator of the claimed invention, having the structure of photonic crystal polarizer/Faraday rotator/glass polarizer/Faraday rotator/photonic crystal polarizer, the reflection return light having passed through the emergent-side photonic crystal polarizer and the plane of polarization of which has been rotated by 45° at the Faraday rotator near to the emergent side crosses the plane of polarization of the middle-positioned glass polarizer to come intercepted.

Since the glass polarizer is an absorption type polarizer as stated previously, the above reflection return light is absorbed in the middle-positioned glass polarizer to come intercepted without being reflected at this glass polarizer.

Accordingly, the broadband semidouble-type optical isolator of the claimed invention enables itself to function as the "optical isolator" defined by the Telcordia Standard because any reflection of the reflection return light does not take place in the interior of the optical isolator.

The above effect of functioning as the "optical isolator" defined by the Telcordia Standard, which is to be brought out by the claimed invention, has been achieved when the middle-positioned polarizer is made up of the glass polarizer and also the outer-side polarizer is made up of the polarizer comprising photonic crystals. Thus, the broadband semidouble-type optical isolator of the claimed invention distinguish over the cited patented publications.

For at least the foregoing reasons, it is submitted that the pending claims are allowable over the patent publications to Chang and Trotter. Accordingly, withdrawal of the outstanding rejection is in order, and such action is respectfully requested.

To the extent necessary during prosecution, Applicant hereby requests any required extension of time not otherwise requested and hereby authorize the commissioner to charge any required fee not otherwise provided, including application processing, extension, and extra claims fees, to Deposit Account 01-2340.

Respectfully submitted,

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Enclosure: EXHIBIT (Figs. 1A-3B)

Telcordia™
Technologies

Performance from Experience

Generic Requirements for Optical Isolators and Circulators

Telcordia Technologies Generic Requirements
GR-2882-CORE
Issue 1, December 1995

Comments Requested (See Preface)

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Contents

List of Figures

2 General Information

• **The requirements and objectives of this document are intended to apply to the following components and applications:**

— used with single-mode fiber in the 1310-nm and 1550-nm regions

— used in the interoffice and subscriber loop plant environment

— used for analog or digital transmission

— used in unidirectional and bidirectional transmission

— used in single-wavelength or wavelength-division-multiplexed transmission

— may be used in an EDFA[1]

— based on any passive component technology as far as mechanical and environmental requirements are concerned, but focusing on Faraday rotator technology for the optical requirements

— having single-mode optical fiber-coupled ports

— having ports with coated fibers, buffered fibers, fiber cable, or with integral optical connectors and no fibers.

• **Requirements and objectives for the following components or applications are not considered in this document:**

— based on active isolating methods or components, apart from optical amplification

— having multimode optical fiber-coupled ports

— isolators that have a higher degree of functionality or that integrate several components in the same package.

The above isolation methods or components may be considered in future issues of this document.

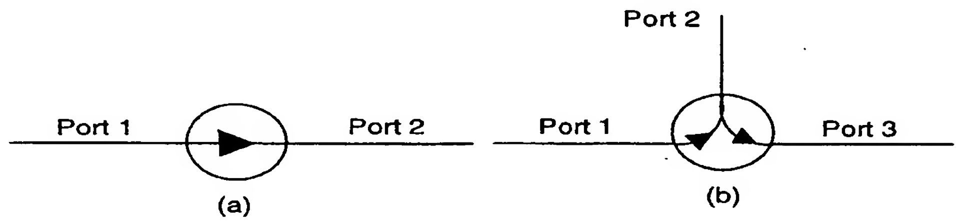
2.1 General Product Description

Reflection induced laser feedback in communications lasers and devices can cause performance to degrade. The most effective way to prevent this is by protecting the laser with an optical isolator, which acts as a one-way valve for a light signal. An optical circulator is a more elaborate nonreciprocal device that directs the light traffic into different paths based its direction of propagation.

Figure 2-1 shows symbols for (a) and optical isolator and (b) a three-port optical circulator.

1. However, detailed EDFA criteria are beyond the scope of this document. See GR-1312-CORE.

Figure 2-1 Symbols for (a) an Optical Isolator, (b) a three-port Optical Circulator



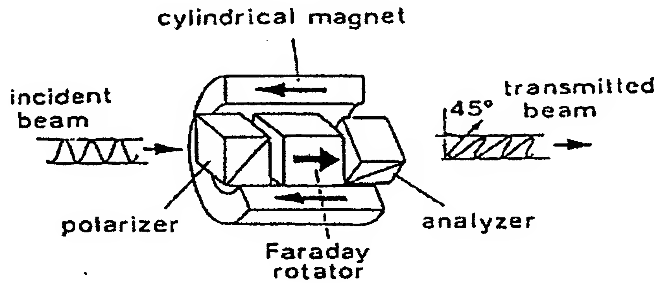
The lines represent optical paths. Ideally, all input power is totally transferred to the output ports (no excess loss) when a lightwave propagates along the optical paths from left to right, and all input power is totally isolated (blocked) to the output ports when a lightwave propagates along the optical paths from right to left. Circulators can have more than three ports by capturing and directing the lightwave in any blocked path to a new port for output.

Optical terms are discussed in more detail in Section 4, in the Appendix, and in the Glossary.

Such nonreciprocal devices are based on the Faraday effect that breaks the time reversal symmetry as the optical signal propagates through a medium with magneto-optical properties.

In 1842, Michael Faraday discovered that the principle plane of polarization of light in glass in a magnetic field is rotated in the same sense, regardless of the direction of the direction of propagation. Thus, for example, when a 45° Faraday rotator is sandwiched between two linear polarizers (as in Figure 2-2, which shows a schematic diagram of this type of isolator) that have their principle planes at + 45° the forward-propagating light is transmitted with very little attenuation (+ means the principle axis of the output polarizer with respect to that of the input polarizer is turned in the same sense as the Faraday rotator).

Figure 2-2 Schematic showing operation of a magneto-optical isolator



However, backward-propagating light from any reflections in the system is polarized by the output polarizer, rotated through the same + 45° by the Faraday rotator, finds itself perpendicular to the principle plane of the input polarizer and is blocked. The performance of an isolator is primarily defined by backward loss (commonly referred to as *isolation*) and the insertion loss. The isolation for an in-line or free-space isolator, I_l, is the ratio of the input power, P_i, to the transmitted power, P_o, in the blocking direction, in units of dB.

$$I_l = 10 \log_{10} (P_i / P_o) \qquad \text{in dB} \qquad \textbf{(2-1)}$$

Extinction ratio for an isolator is the ratio of transmitted to blocked power, but for most isolators, in which isolation is much higher than insertion loss, the extinction ratio approximately equals the isolation.

The isolation of a device depends on the overall design as well as the quality of materials and processing steps used in the construction. In the polarizer/analyzer design of Figure 2-2 the extent to which such an isolator succeeds in suppressing backreflection depends on the extinction ratio of the input/output polarizers, reflected stray light from the individual elements, and the accuracy and stability of the + 45° Faraday rotator. Materials as well as structural parameters usually tend to confine the operating wavelength and temperature range of the device. Figure 2-3 shows an example of the temperature dependence of backward loss for single-stage and double-stage isolators.